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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2007	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Space Programs and Technology PE 0603287E				
COST (In Millions)	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	210.736	253.950	224.551	225.238	246.443	244.598	249.467	258.867
Space Programs and Technology SPC-01	210.736	253.950	224.551	225.238	246.443	244.598	249.467	258.867

(U) Mission Description:

(U) The Space Programs and Technology program element is budgeted in the Advanced Technology budget activity because it addresses high payoff opportunities to dramatically reduce costs associated with advanced space systems and provides revolutionary new system capabilities for satisfying current and projected military missions.

(U) A space force structure that is robust against attack represents a stabilizing deterrent against adversary attacks on space assets. The keys to a secure space environment are situational awareness to detect and characterize potential attacks, a proliferation of assets to provide robustness against attack, ready access to space, the ability to neutralize man-made space environments, and a flexible infrastructure for maintaining the capabilities of on-orbit assets. Ready access to space allows the delivery of defensive systems and replenishment supplies to orbit. An infrastructure to service the mission spacecraft allows defensive actions to be taken without limiting mission lifetime. In addition, developing space access and spacecraft servicing technologies will lead to reduced ownership costs of space systems and new opportunities for introducing technologies for the exploitation of space.

(U) Systems development is also required to increase the interactivity of space systems, space-derived information and services with terrestrial users. Studies under this project include technologies and systems that will enable satellites and microsatellites to operate more effectively by increasing maneuverability, survivability, and situational awareness; enabling concepts include solar thermal propulsion, novel ion-thruster applications, payload isolation and pointing systems.

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(U) Program Accomplishments/Planned Programs:

	FY 2006	FY 2007	FY 2008	FY 2009
Orbital Express Space Operations Architecture	35.271	34.711	0.000	0.000

(U) The goal of the Orbital Express Space Operations Architecture program is to validate the technical feasibility of robotic, autonomous on-orbit refueling and reconfiguration of satellites to support a broad range of future U.S. national security and commercial space programs. Refueling satellites will enable frequent maneuver to improve coverage, change arrival times to counter denial and deception and improve survivability, as well as extend satellite lifetime. Electronics upgrades on-orbit can provide regular performance improvements and dramatically reduce the time to deploy new technology on-orbit. The Orbital Express advanced technology demonstration will design, develop and test on-orbit a prototype servicing satellite (ASTRO) and a surrogate next generation serviceable satellite (NextSat). The elements of the Orbital Express demonstration, coordinated with Air Force Space Command and Air Force Space and Missile Command, will be tied together by non-proprietary satellite servicing interfaces (mechanical, electrical, etc.) that will facilitate the development of an industry wide on-orbit servicing infrastructure. NASA will apply the sensors and software developed for autonomous rendezvous and proximity operations to reduce risk for collaborative human-robotic operations in space for the NASA Exploration Initiative. Launch of the demonstration system is scheduled for early 2007 on the Air Force Space Test Program's STP-1 mission.

(U) Program Plans:

- Develop and validate software for autonomous mission planning, rendezvous, proximity operations and docking.
- Design, fabricate, and test on-orbit robotic satellite servicing, including fuel and electronics transfer, deployment of and operations with a micro-satellite.
- Perform utility assessments of on-orbit servicing in conjunction with operational customers and plan for technology transition.

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	FY 2006	FY 2007	FY 2008	FY 2009
Space Surveillance Telescope	18.592	19.771	12.833	3.000

(U) The Space Surveillance Telescope (SST) program will develop and demonstrate an advanced ground-based optical system to enable detection and tracking of faint objects in space, while providing rapid, wide-area search capability. A major goal of the SST program is to develop the technology for large curved focal plane array sensors to enable an innovative telescope design that combines high detection sensitivity, short focal length, wide field of view, and rapid step-and-settle to provide orders of magnitude improvements in space surveillance. This capability will enable ground-based detection of un-cued objects in deep space for purposes such as asteroid detection and space defense missions. The Air Force will participate in the DARPA funded developmental testing of SST and then take over operation of SST as a sensor in the Air Force Space Surveillance Network. An MOA has been established with Air Force Space Command for transition at the conclusion of Phase II that is anticipated to be completed in FY 2009.

(U) Program Plans:

- Develop, fabricate, and integrate a mosaic of curved focal plane arrays into a wide field-of-view detector system.
- Develop, fabricate, and integrate a 3.5m aperture telescope with both a wide field of view and high sensitivity.
- Develop, test, and validate software for autonomous telescope operations and data reporting.
- Design and fabricate telescope enclosure and supporting infrastructure at White Sands Missile Range.
- Validate end-to-end telescope performance and surveillance operations.
- Perform operational evaluation in conjunction with the Air Force.

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	FY 2006	FY 2007	FY 2008	FY 2009
Innovative Space-Based Radar Antenna Technology (ISAT)	43.000	22.000	0.000	0.000

(U) The Innovative Space-Based Radar Antenna Technology (ISAT) effort designed radically new enabling technologies and design methods for extremely large space-based radio frequency (RF) antenna technologies necessary for tactical-grade ground moving target indicator (GMTI) radar. Up to 300 meters long electronically scanned antenna (ESA) designs were developed by leveraging major advances in novel materials (such as rigidized inflatables and shape memory polymers), packing techniques and ultra lightweight low-power density RF electronics. An antenna of this size would enable a medium earth orbit (MEO) constellation that would provide 24/7 true continuous coverage with 10 to 12 satellites (about 96 satellites at low earth orbit (LEO) would be required to provide the same level of coverage). ISAT would also enable detection and tracking of all airborne targets. The ISAT program addressed the risk associated with two major technical obstacles: 1) the reliable and controllable deployment of a ~300 meter long ESA with a linear compaction ratio of 100:1; and 2) the on-orbit calibration (particularly on transmit) and control of the ISAT antenna. Novel power distribution systems were also investigated. The program conducted ground-based risk reduction experiments demonstrating the accuracy of the constitutive models for deployment and control of large antenna structures and also developed concepts of operations, performance predictions and lifecycle cost models for the selected designs, as well as investigated the applicability of the technologies to other missions. The program ended in FY 2007.

(U) Program Plans:

- Tested the mechanical and environmental properties of materials and structural components.
- Simulated metrology and calibration approaches for large space antenna structures.
- Initiated development of next-generation lightweight electronics, materials and deployment structures.
- Designed risk reduction demo experiments.
- Performed ground-based risk reduction experiments of the metrology and calibration approaches in preparation for on-orbit demonstration.
- Perform ground-based risk reduction experiments for packaging and deployment mechanisms and materials, including simulation of mechanical and thermal loads.

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	FY 2006	FY 2007	FY 2008	FY 2009
Novel Satellite Communications	8.500	16.275	15.622	9.639

(U) The aim of the Novel Satellite Communications (NSC) program is the development of a multi-user satellite communications (SATCOM) system that allows ground-based users with handheld radios to communicate with the satellite at high data rates, even when the users are close to multiple jammers and/or located in urban (i.e. severe multi-path) settings. This will be accomplished through novel signal processing, communications and coding techniques. The NSC technology will transition to the U.S. Navy (SPAWAR) and U.S. Air Force (SMC) following the NSC demonstration in 2009.

- (U) Program plans:
- Determined feasibility of novel concepts to enable robust communications in the presence of multiple nearby jammers.
 - Develop signal processing, communications and coding techniques that fully exploit the novel concepts to provide a robust anti-jam capability in the presence of multiple nearby jammers.
 - Carry out proof-of-concept demonstrations.

	FY 2006	FY 2007	FY 2008	FY 2009
Integrated Sensor is Structure (ISIS)	0.000	23.318	26.200	35.000

(U) The ISIS program is developing a sensor of unprecedented proportions that is fully integrated into a stratospheric airship that will address the nation's need for persistent wide-area surveillance, tracking, and engagement for hundreds of time-critical air and ground targets in urban and rural environments. ISIS is achieving radical sensor improvements by melding the next-generation technologies for enormous lightweight antenna apertures and high-energy density components into a highly-integrated lightweight multi-purpose airship structure - completely erasing the distinction between payload and platform. The ISIS concept includes 99% on-station 24/7/365 availability for Simultaneous Airborne Moving Target Indicator (AMTI) (600 kilometers) and Ground-Based Moving Target Indicator (GMTI) (300 kilometers) operation; 12-plus months of autonomous, unmanned flight; hundreds of wideband in-theater covert communications links; responsive reconstitution of failed space assets; plus

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CONUS-based sensor analysis and operation. The ISIS technology is planned for transition to the Army's PEO ASMD, Air Force Joint Warfighter Space and the Missile Defense Agency at the conclusion of Phase IV, which is anticipated to be completed by FY 2011. This program was funded under PE 0603767E, Project SEN-01 in FY 2006 and prior years.

(U) Program Plans:

- Developed objective system concept designs enabling simultaneous AMTI and GMTI operation, one year logistics-free operation, 99% on-station availability, and high-bandwidth covert communications.
- Identified specific mass-reducing technologies for key radar, power, and airship components.
- Develop and demonstrate lightweight technologies for system integration (i.e. high-energy density batteries, electronic circuits on thin-film barrier materials, advanced multi-purpose airship hulls, and regenerative fuel technologies).
- Design and simulate new radar modes: tracking air and ground targets through the clutter notch; detection and response to rockets, artillery, and mortars (RAM); detection of dismounted enemy combatants; and “track-all-the-way” fire-control.
- Design, build and demonstrate a fully-operational scaled flight system demonstrating complete system integration over an extended period (~3 months).

	FY 2006	FY 2007	FY 2008	FY 2009
Deep View	10.920	10.250	8.450	4.250

(U) The Deep View program will develop a high-resolution radar imaging capability to characterize objects in earth orbit. A special emphasis will be placed on imaging small objects at orbits ranging from low earth orbit (LEO) to geo-stationary orbit (GEO). The system will be based upon a large aperture imaging radar system redesigned to operate at very high power over very broad bandwidth at W-band. Key technology development will focus on: (1) transmitters capable of providing the required power to image at deep-space ranges over full bandwidth; and (2) an antenna design that maintains the necessary form factor over a very large aperture. The capabilities emerging from this program will enable the classification of unknown objects, such as space debris, as well as the monitoring of the health and status of operational satellites. DARPA established an MOA with the Air Force for this program in August 2004. The Deep View technology is planned for transition to the Air Force at the conclusion of Phase III, which is anticipated to be completed by FY 2010.

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(U) Program Plans:

- Develop W-band gyro-twysteron transmitter tubes.
- Develop the technology for W-band power combining and frequency multiplexing, to obtain the required transmitter power over the required bandwidth for deep space imaging.
- Complete transmitter and radar system design, retaining the current Haystack X-band capability.
- Develop advanced signal processing software required by the new broadband high power transmitter approach.
- Integrate into a low-power radar configuration providing LEO-only imaging capability.
- Demonstrate LEO-GEO imaging capability using a full set of gyro-twysters.

	FY 2006	FY 2007	FY 2008	FY 2009
Long View (formerly Ground Based Imaging)	0.000	7.496	13.809	19.789

(U) The Long View program will develop an inverse synthetic aperture laser radar (LADAR) that will enable the high-resolution imaging of geostationary satellites when coupled to a large aperture telescope. Specifically, the technologies being developed in the Long View program are an optical reference oscillator that is stable over the propagation time to a geostationary satellite (GEOSTAT) and back (about a quarter of a second) and autofocus algorithms that restore image quality that has been degraded due to atmospheric turbulence and optical reference oscillator instability over the imaging time (about 100 seconds). These two technologies are required in order to make inverse synthetic aperture LADAR systems feasible for objects in geostationary orbits.

(U) Program Plans:

- Develop stable optical reference oscillator.
- Develop and test autofocus algorithms.
- Measure atmospheric turbulence statistics at sub-Hz frequencies.
- Design, build, and test demonstration hardware.
- Integrate hardware with telescope.
- High resolution imaging of geostationary satellites.

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	FY 2006	FY 2007	FY 2008	FY 2009
Falcon	38.600	51.500	50.000	49.500

(U) The Falcon program objectives are to develop and demonstrate hypersonic technologies that will enable prompt global reach missions. This capability is envisioned to entail a reusable Hypersonic Cruise Vehicle (HCV) capable of delivering 12,000 pounds of payload at a distance of 9,000 nautical miles from CONUS in less than two hours. The technologies required by a HCV include high lift-to-drag technologies, high temperature materials, thermal protection systems, and guidance, navigation, and control. Leveraging technology developed under the Hypersonic Flight (HyFly) program, Falcon will address the implications of hypersonic flight and reusability using a series of hypersonic technology vehicles (HTVs) to incrementally demonstrate these required technologies in flight. In order to implement this flight test program in an affordable manner, Falcon will develop a low cost, responsive Small Launch Vehicle (SLV) that can be launched for \$5M or less. In addition to HTV sub-orbital launches, the SLV will be capable of launching small satellites into low earth and sun-synchronous orbits and will provide the nation a new, small payload access to space capability. Thus, the Falcon program addresses many high priority mission areas and applications such as global presence and space lift. DARPA established an MOA with the Air Force for this program in May 2003 and with NASA in October 2004. Falcon capabilities are planned for transition to the Air Force.

(U) Program Plans:

- Conducted SLV first stage static firing and launch from Omelek Island.
- Conducted full scale size, subscale weight, air launch drop test.
- Conducted SLV responsive operations demonstration.
- Conducted HTV-2 preliminary design review.
- Conducted HTV-3X feasibility study.
- Conducted multiple full scale size, full scale weight air launch drop tests.
- Conducted SLV full scale engine firings.
- Conduct SLV risk reduction flight for TacSat-1 launch mission.
- Conduct critical design review of HTV-2 demonstration system, and initiate fabrication.
- Complete HTV-2 aeroshell prototype fabrication and conduct leading-edge arc-jet test.

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- Conduct critical design review of SLV, and initiate fabrication.
- Initiate concept design of the HTV-3X technology flight demonstration vehicle.
- Conduct SLV flight demonstration.
- Conduct flight testing of HTV-2 incorporating next generation hypersonic technologies.
- Conduct flight-testing of advanced reusable technologies for HCV.

	FY 2006	FY 2007	FY 2008	FY 2009
Rapid On-Orbit Anomaly Surveillance and Tracking (ROAST)	2.000	0.000	0.000	0.000

(U) The Rapid On-Orbit Anomaly Surveillance and Tracking (ROAST) program developed technologies to enable low-cost, responsive spacecraft and capabilities, such as space situational awareness and blue force tracking. Key payload technologies included light-weight optics, adaptive focal plane array sensors, and efficient space-qualified receivers and processors.

- (U) Program Plans:
- Evaluated light-weight, large area optics fabrication capabilities.

	FY 2006	FY 2007	FY 2008	FY 2009
Sleight of HAND (SOH)	4.482	11.870	12.710	7.160

(U) This program will leverage technologies developed under the Air Force's High Frequency Active Auroral Research Program (HAARP) program. The effects of High Altitude Nuclear Detonations (HAND) are catastrophic to satellites. HAND-generated charged particles are trapped for very long periods of time, oscillating between the earth's north and south magnetic poles. This enhanced radiation environment would immediately degrade low earth orbiting (LEO) spacecraft capability and result in their destruction in a short period of time. The Sleight of HAND (SOH) program is a proof of concept demonstration of the technology and techniques to mitigate the HAND-enhanced trapped radiation. The goal of SOH is to accelerate the rate of decay of trapped radiation from the LEO environment by a factor of 10 over the natural rate of decay. In Phase

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1, SOH will use a high power ground-based source of very low frequency (VLF) radiation propagating through the ionosphere to deflect the trapped radiation deep into the atmosphere. If the ground-based proof of concept shows VLF radiation remediation concepts are valid and cost-effective, a space-based demonstration that may lead to an operational capability will be pursued. If successful, follow-on programs to perform HAND produced radiation remediation will be pursued by the Air Force.

(U) Program Plans:

- Developed VLF propagation and radiation interaction/effects model.
- Constructed and deployed an instrumented buoy to sense and report VLF signal strength and effects of VLF on trapped radiation.
- Utilized the HAARP facility to perform 1-hop experiments to anchor VLF propagation and interactions model.
- Performed 2-hop experiments to further enhance the fidelity of VLF prediction codes.
- Use results of ground-based SOH experiments to develop requirements for a space-based SOH demonstrator.
- Evaluate requirements for space-based SOH demonstration.

	FY 2006	FY 2007	FY 2008	FY 2009
Suborbital Space Launch Operations / Improving Suborbital Operations	5.600	0.000	0.000	0.000

(U) The Suborbital Space Launch Operations/Improving Suborbital Operations program designed and developed an unmanned, reusable suborbital launch vehicle whose near term goal was to perform short duration testing of space flight hardware and ultimately to provide a platform for tactical battlefield surveillance.

(U) Program Plans:

- Developed a preliminary system design for the launch vehicle.
- Conducted system requirements review and initiate detailed design.

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	FY 2006	FY 2007	FY 2008	FY 2009
Micro Electric Space Propulsion	3.236	4.689	6.748	0.000

(U) The Micro Electric Space Propulsion program (MEP) will demonstrate flexible, light-weight, high-efficiency, scalable micro-propulsion systems to enable a new generation of fast, long-lived, highly flexible, and highly maneuverable 1-100 kg-class satellites/spacecraft. In particular, the goals of the program are to demonstrate a thruster system capable of: (1) varying its specific impulse in real time across a range from 500 seconds to 10,000 seconds utilizing a single propellant, (2) operating with electrical thrust efficiencies in excess of 90% over significant portions of this range, (3) demonstrating a thruster specific mass less than 0.3 g/watt, and (4) demonstrating a propulsion system capable of delivering total mission delta-Vs for a 100 kg satellite in excess of 10 km/s. The MEP technology is planned for transition to the Air Force at the conclusion of Phase I, which is anticipated to be completed in FY 2008.

(U) Program Plans:

- Demonstrate proof-of-principle 1 watt thruster system capable of operating 50% efficiency at 2500 seconds and 7000 seconds specific impulse.
- Design 2-D thruster array.
- Develop and demonstrate required Microelectromechanical Systems (MEMS) fabrication process, including development of high-aspect ratio machining and conformal surface modification techniques.
- Develop robust system design capable of tolerating single emitter failure.
- Initiate propellant selection and optimization.
- Demonstrate thruster / propellant material compatibility.
- Demonstrate thruster operation.

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	FY 2006	FY 2007	FY 2008	FY 2009
RAD Hard by Design	10.000	6.000	6.000	3.500

(U) This program is developing, characterizing, and demonstrating microelectronic design technologies to enable fabrication of radiation hardened electronic components using leading-edge, commercial fabrication facilities. The current mainstream approach for fabricating radiation-hardened electronics depends on specialized process technologies and dedicated foundries that serve this military market niche. While commercial semiconductor fabrication is not explicitly radiation hardened, recent trends in deeply scaled fabrication such as very thin oxides, trench isolation, and multiple levels of metal are resulting in semiconductor devices that are inherently more tolerant of radiation than older generations. This program is pursuing development of design-based technologies that will enable pure commercial fabrication technologies to attain radiation hardened electronics equivalent to those from the dedicated foundries. The design technology developed under the Radiation Hardening by Design Program is planned for transition to the Air Force and to the Defense Threat Reduction Agency (DTRA) at the end of Phase 2, which is anticipated to be completed by FY 2009. Specific design libraries for hardened circuits will transition through the defense electronics design industry, which are being supported largely by DTRA and the Air Force.

(U) Program Plans:

- Prove that a pure design-based approach will be capable of attaining radiation hardened electronic devices with less than one generation penalty in terms of device area, speed, and power.
- Create design libraries needed for implementing radiation hardened integrated circuits.
- Demonstrate the ability to design and fabricate a fully hardened complex circuit using developed design-based methodology and leading edge commercial fabrication facilities.

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	FY 2006	FY 2007	FY 2008	FY 2009
Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP)	7.000	8.000	11.000	11.000

(U) The Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP) program will develop the advanced technologies, capabilities, and space environment characterization required to demonstrate a suite of advanced lightweight microsatellite technologies integrated into high performance microsatellites across the continuum from low earth orbit (LEO) to deep space Super geo-synchronous orbit (GEO) environment. The program will integrate a variety of advanced technologies, which have not been previously flight-tested, and may include: lightweight optical space surveillance/situational awareness sensors, lightweight power, chemical and electric propulsion systems, advanced lightweight structures, advanced miniature RF technology including micro crosslink and use of Commercial Off the Shelf (COTS) approaches, active RF sensor technology, COTS processor and software environment, miniature navigation technologies, including the use of starfields for deep space navigation, and autonomous operations. The developed capabilities may include high thrust, high efficiency solar thermal propulsion systems that can enable responsive orbit transfer as well as provide radiation resistant high density electrical power; ultra-stable payload isolation and pointing systems; and components to enable advanced miniature communication systems. The program will also consider affordable, responsive fabrication and integration approaches and the possibility of networking microsatellites/modules to create a flexible architecture of assets responsive to multiple missions and threats. If successful, MiDSTEP will demonstrate these technologies in space. The anticipated transition partner is USAF Space Command.

(U) The Microsatellite Technology Experiment (MiTEx) technology demonstration investigated and demonstrated advanced high-payoff technologies from a variety of potential candidates, including: lightweight power and propulsion systems, avionics, structures, commercial off-the-shelf (COTS) components, advanced communications, and on-orbit software environments. MiTEX flight tested a new, experimental upper stage, and demonstrated small COTS technologies to support a fast-paced, low-cost, lab-like, build-to-launch satellite approach in a shared industry/government environment.

- (U) Program Plans:
- Conduct system design trades of appropriate technologies.
 - Perform mission utility assessments and feasibility studies and develop concepts of operation.

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- Design and develop microsatellite system concepts and integrate selected technologies.
- Perform component and subsystem ground tests, fabricate and flight test microsatellite system.

	FY 2006	FY 2007	FY 2008	FY 2009
System F6	9.235	12.224	17.779	21.200

(U) The goal of System F6 program is to demonstrate a radically new space system composed of a heterogeneous network of formation flying or loosely connected small satellite modules that will, working together, provide at least the same effective mission capability of a large monolithic satellite. Current large space systems used for national security purposes are constrained due to their monolithic architecture. They can be launched only on a small number of large launch vehicles, cannot readily be upgraded and/or reconfigured with new hardware on-orbit, and are risk-intensive, since the unforgiving launch and space environments can result in a total loss of investment with one mistake. The System F6 will partition the tasks performed by monolithic spacecraft (power, receivers, control modules, etc.) and assign each task to a dedicated small or micro satellite. This fractionated space system offers the potential for reduced risk, greater flexibility (e.g. simplified on-orbit servicing, reconfigurability to meet changing mission needs), payload isolation, faster deployment of initial capability, and potential for improved survivability. This program will develop, design, and test new space system architectures and technologies required to successfully decompose a spacecraft into fundamental elements. Such architectures include, but are not limited to, ultra-secure intra-system wireless data communications, wireless power systems, electromagnetic formation flying systems, remote attitude determination systems, structure-less optical and RF arrays, and distributed spacecraft computing systems. The anticipated transition partner is the USAF.

(U) Program Plans:

- Conduct system design trades of appropriate technologies and system architectures.
- Perform mission utility and econometric-based value assessments and feasibility studies and develop concepts of operations.
- Design and develop fractionated system concepts and integrate selected technologies.
- Perform component and subsystem ground tests.
- Fabricate and space test a microsatellite-scaled fractionated space system.

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	FY 2006	FY 2007	FY 2008	FY 2009
Front-end Robotics Enabling Near-term Demonstration (FRIEND)	9.100	13.196	14.400	12.700

(U) The goal of the Front-end Robotics Enabling Near-term Demonstration (FRIEND) program is to develop, demonstrate and fly technologies designed to increase the survivability and operational effectiveness of geosynchronous (GEO) orbit-based military and commercial spacecraft. Existing GEO spacecraft are outfitted with sufficient propellant to provide for needed stationkeeping, repositioning, and retirement maneuvers, which in many cases defines their useful mission durations. Once this propellant is expended, the vehicle is retired and, in many cases replaced. FRIEND can enable significant service extension to these spacecraft through reboosting near end-of-life. FRIEND combines detailed stereo photogrammetric imaging with robotic multi-degree-of-freedom manipulators to autonomously grapple space objects not outfitted with custom interfaces. FRIEND offers the potential for spacecraft salvage, repair, rescue, reposition, de-orbit and retirement, and debris removal. The anticipated transition partner is USAF Space Command.

(U) Program Plans:

- Design, fabrication, and ground testing of the rendezvous sensor and robotic payload elements using flight hardware.
- Complete risk reduction lab test.
- Develop control algorithms for autonomous grapple and contingency operations.
- Procure and fabricate flight hardware for integration and testing.
- Conduct robotic payload ground test.
- Test control schemes in 1G environment.
- Conduct hardware-in-the loop testing in proximity operations test facility.
- Work with mission partner for full system integration and mission.

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	FY 2006	FY 2007	FY 2008	FY 2009
X-ray Navigation and Autonomous Position Verification (XNAV)	5.200	3.550	0.000	0.000

(U) The X-ray Navigation and Autonomous Position Verification (XNAV) program sought to use periodic x-ray celestial sources to determine the three-dimensional position, attitude and time of orbiting spacecraft. XNAV explored the concept of operations (CONOPs) of a spacecraft equipped with an x-ray imager and photon counter to determine the feasibility and accuracy of x-ray pulsar sources for autonomous position, attitude, and time determination in low earth orbit (LEO) for DoD navigation and communication satellites.

- (U) Program Plans:
- Determined x-ray detector sensitivity, response time, signal-to-noise properties, and timing electronics.
 - Demonstrated expected navigation performance via detailed simulation.
 - Catalogued properties of rotation powered pulsar sources for navigation.
 - Developed preliminary x-ray detector system designs developed for the ISS Express Pallet.

	FY 2006	FY 2007	FY 2008	FY 2009
Fast Access Spacecraft Testbed (FAST)	0.000	4.300	7.000	9.000

(U) The goal of the Fast Access Spacecraft Testbed (FAST) program is to demonstrate a suite of critical technologies required to perform rapid orbital repositioning in the geosynchronous belt. A high-efficiency, high-power (50-80 kW), fast-transfer roaming satellite would permit on-demand access to any point on the geosynchronous ring or within the high-altitude, supersynchronous “graveyard” (where derelict systems are regularly repositioned in order to free up orbital slots within the ring), greatly improving our space situational awareness capabilities. The FAST demonstrator satellite, while possessing high power, would be revolutionary in its small size. At just 500 kilograms, the FAST spacecraft would carry a novel solar power collection and distribution system, composed of large-aperture (5-10 m diameter) concentrating mirrors, high-efficiency solar photovoltaics, and ultralightweight, deployable radiators, achieving specific power (watts/kilogram) levels an order of magnitude better than today’s state of the art. The anticipated transition partner is the Air Force.

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(U) Program Plans:

- Conduct system design trades and investigate utility of applicable power and propulsion technologies.
- Perform preliminary design and technology selection.
- Perform detailed design and development of the FAST spacecraft, integrating selected technologies.
- Fabricate, qualify, and launch the FAST spacecraft to a low earth orbit to demonstrate proof-of-concept.

	FY 2006	FY 2007	FY 2008	FY 2009
Tiny, Independent, Coordinating Spacecraft (TICS)	0.000	4.800	6.000	7.000

(U) The Tiny, Independent, Coordinating Spacecraft (TICS) program is intended to leapfrog the microsatellite revolution, not simply through downsizing but through the addition of advanced robotics technologies to allow satellites to reconfigure on demand, many times over during the course of a mission. TICS will develop key technologies to permit the delivery of small, difficult-to-detect nanosatellites (1-10 kg) into any common operational orbit, from low earth orbit (LEO) to geosynchronous orbit (GEO), with little or no advance warning. TICS could be hosted aboard “mothership” platforms in LEO or GEO, or could be delivered directly via ultra-light launch platforms. Such systems could perform rapid-response reconnaissance on any spacecraft, with times to mission orbit measured in just hours. Such systems would be composed of modular, dockable subassemblies that could autonomously modify their morphologies to become apertures, free-flying formations, crawlers, or booms, as dictated by mission need. A TICS aggregate will be capable of assembling, disassembling, dispersing, and subsequently re-assembling several times over. Enabling technologies include high-efficiency, miniaturized radar and active/passive optical sensors, multi-functional structures, software for advanced autonomous behavior (to include the ability to rendezvous, dock, undock, and formation-fly in multiple configurations), electric or chemical microthrusters, high energy density storage systems (including supercapacitors and advanced batteries), high efficiency energy conversion, and robust end effectors. The anticipated transition partner is the Air Force.

(U) Program Plans:

- Conduct system design trades and provide “proof-of-concept” for a strawman TICS architecture.
- Conduct preliminary design, analysis, and key technology demonstrations.

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- Perform detailed design and development of a TICS nanosatellite, integrating selected technologies and demonstrating aggregate behavior in a simulated space environment.

	FY 2006	FY 2007	FY 2008	FY 2009
NanoPayload Delivery (NPD)	0.000	0.000	4.000	8.500

(U) The goal of the NanoPayload Delivery (NPD) program is to validate the technical feasibility of ultralightweight, rapid-response spacecraft delivery from land, sea, or air-based platforms. Such nanopayloads (1-10 kilograms) could be boosted to low earth orbit (200 km altitude) in a matter of hours following call-up. Multiple sorties are envisioned, enabling a number of small spacecraft to be placed in an orbit “box” and aggregated together to perform a mission. The NPD program will develop and test a lightweight rocket platform similar in size to existing small missile systems such as the High-Speed Anti-Radiation Missile (HARM), AIM-7, or AIM-120. Current technology does not permit such small systems to reach orbit, owing to disproportionately high drag and low thrust-to-weight rocket engines. NPD will leverage ongoing technology development efforts, which permit the fabrication of microscale pumps, thrust chambers, and valves. Such rocket engines, which are theoretically capable of thrust-to-weight ratios of 100:1 or greater, would allow for significant reductions in overall engine mass and permit nanosatellites to be placed in low orbits for several weeks to months. The delivery system would rely on one of several methods for launch, including: (1) a stock aircraft, such as the F-15E or F-16, (2) a truck-mounted erector, or (3) the deck of a small naval vessel. The goal for per-sortie cost is \$100,000. Fielding NPD will permit U.S. forces to rapidly emplace short-term capabilities in low orbit, when they are needed, without resorting to legacy domestic launch systems that are sized and costed for much larger payloads. NPD will also allow many non-traditional users (e.g. laboratories, operational commanders, and small commercial firms) the capability to “use space” by lowering the significant barrier to entry into space. NPD will allow a streamlined, inexpensive approach to launch, descoping lengthy test and documentation requirements and demanding far fewer engineers, technicians, range personnel, and spacecraft operators per mission.

(U) Program Plans:

- Survey existing aircraft-, land-, and sea-based missile platforms for compatibility with nanopayload delivery mission constraints and requirements.

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- Design, fabricate, and test an integrated micro chemical engine; including pumps, lines, valves, and thrust chamber; to validate performance models.
- Design, develop, and test arrays of micro engines for use as the first and upper stages of the NPD rocket platform.
- Integrate and test micro engine arrays on selected missile platforms.
- Perform aircraft-based launch demonstration of one or more nanopayloads.

	FY 2006	FY 2007	FY 2008	FY 2009
Space Situational Awareness & Counterspace Operations Response Environment	0.000	0.000	5.000	9.000

(U) The goal of the Space Situational Awareness (SSA) & Counterspace Operations Response Environment (SCORE) program is to develop and demonstrate an operational framework and responsive defense application to enhance the availability of vulnerable commercial space-based communications resources. SCORE will correlate a wide range of operational support and space system ground user data to rapidly identify threat activities, propose mitigating countermeasures, and verify the effectiveness of selected responses. Critical technologies include accessing disparate sources of relevant data, model-based situational awareness, and candidate response generation and evaluation. Particular emphasis will be placed on the ability to continuously adapt to changes in defended system components and usage patterns as well as validation of SCORE system integrity.

- (U) Program Plans:
- Develop initial system requirements and design.
 - Develop adaptive model of defended systems and identify relevant sources of data.
 - Conduct system trades and validate critical components.
 - Mature system parameters and operational procedures.
 - Demonstrate integrated system performance.

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	FY 2006	FY 2007	FY 2008	FY 2009
Air Collection and Enrichment System (ACES)	0.000	0.000	5.000	10.000

(U) The Air Collection and Enrichment System (ACES) is an in-flight propellant collection system, which generates liquid oxygen (LOX) through the cryogenic separation of atmospheric air. Since it allows vehicles to take off without LOX on board—minimizing vehicle takeoff weight—the ACES technology is critical for Horizontal Takeoff, Horizontal Landing (HTHL) architectures to meet future launch vehicle safety, economic, and operational goals. The ACES enables reusable launch vehicles that operate with existing air-breathing and rocket propulsion systems to create a paradigm shift in space operations. The ACES program will build and test a palletized ACES system that can be proven on the ground and then flown on a test aircraft. This palletized system would use bleed air from the test aircraft to create rocket grade LOX. Successful completion would lead to a full scale flight demonstration of a Two Stage to Orbit (TSTO) system. This program will allow a TSTO aircraft to generate its own LOX onboard during flight, which will reduce the overall vehicle take off weight and allow more payload weight to be placed in orbit.

(U) Program Plans:

- Develop and construct a boilerplate Rotating Low Pressure Column Fractional Distillation Unit (RFDU) capable of generating rocket grade LOX from aircraft engine or industrial compressor bleed air.
- Modify RFDU hardware to improve efficiency and LOX purity.
- Integrate ACES on a test aircraft and demonstrate LOX generation capability in flight.

	FY 2006	FY 2007	FY 2008	FY 2009
X-ray Communication in Space (XCOM)	0.000	0.000	2.000	5.000

(U) The X-ray Communication in Space (XCOM) program will develop a robust integrated communication solution to counter the potential for adversaries to disrupt or intercept secure spacecraft-to-spacecraft communication links to the warfighter. Specifically, XCOM will develop a novel x-ray modulator and detector with associated collimating optics for capturing photons at high signal-to-noise ratios and nanosecond timing

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resolution. In addition, modulated signals from x-ray sources could simultaneously be used to perform relative navigation either as an x-ray beacon or in a two-way time transfer mode where on-board clock times are transmitted along the modulated two x-ray communication links in a form similar to microwave based two-way time transfer. Relative navigation based on this methodology has been estimated to be on the order of centimeters.

(U) Program Plans:

- Demonstrate a low cost x-ray modulator; a high intensity x-ray source that can be tuned to specific energy bands (10 to 100 keV).
- Demonstrate high timing resolution x-ray detector (< ns) to receive transmitted photons at data rates near 10 Mbits per second.
- Integrate modulator and detector, demonstrate secure X-ray communications, and transition to military or intelligence user.

(U) **Program Change Summary:** *(In Millions)*

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Previous President's Budget	216.357	254.913	294.648	317.360
Current Budget	210.736	253.950	224.551	225.238
Total Adjustments	-5.621	-0.963	-70.097	-92.122
 Congressional program reduction	 0.000	 -0.963		
Congressional increases	0.000			
Reprogrammings	0.000			
SBIR/STTR transfer	-5.621			

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(U) Change Summary Explanation:

FY 2006	The decrease reflects the SBIR/STTR transfer.
FY 2007	The decrease reflects the reduction for Section 8106 Economic Assumptions.
FY 2008/2009	Decrease reflects the completion of the Orbital Express and ISAT programs.

(U) Other Program Funding Summary Cost:

Falcon	FY 2006	FY 2007	FY 2008	FY 2009
PE 0604855, Air Force SPC	23.354	16.000	0.000	0.000
PE 0604856, Air Force SPC	23.000	26.500	23.500	11.000
Deep View	FY 2006	FY 2007	FY 2008	FY 2009
PE 0305910F, Air Force SPC	18.511	0.000	0.000	0.000
PE 0305940F, Air Force SPC	0.000	13.576	8.859	0.709
Space Surveillance Telescope	FY 2006	FY 2007	FY 2008	FY 2009
USAF	0.000	0.000	0.000	1.100

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